52. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

PROCCEDINGS | 10 - 13 September 2007

FACULTY OF COMPUTER SCIENCE AND AUTOMATION

COMPUTER SCIENCE MEETS AUTOMATION

VOLUME II

Session 6 - Environmental Systems: Management and Optimisation
Session 7 - New Methods and Technologies for Medicine and Biology
Session 8 - Embedded System Design and Application
Session 9 - Image Processing, Image Analysis and Computer Vision
Session 10 - Mobile Communications
Session 11 - Education in Computer Science and Automation

TECHNISCHE UNIVERSITÄT ILMENAU

Bibliografische Information der Deutschen Bibliothek
Die Deutsche Bibliothek verzeichnet diese Publikation in der deutschen Nationalbiografie; detaillierte bibliografische Daten sind im Internet über **http://dnb.ddb.de** abrufbar.

ISBN 978-3-939473-17-6

Impressum

Herausgeber:	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Peter Scharff
Redaktion:	Referat Marketing und Studentische Angelegenheiten Kongressorganisation Andrea Schneider Tel.: +49 3677 69-2520 Fax: +49 3677 69-1743 e-mail: kongressorganisation@tu-ilmenau.de
Redaktionsschluss:	Juli 2007
Verlag:	Technische Universität Ilmenau/Universitätsbibliothek Universitätsverlag Ilmenau Postfach 10 05 65 98684 Ilmenau www.tu-ilmenau.de/universitaetsverlag
Herstellung und Auslieferung:	Verlagshaus Monsenstein und Vannerdat OHG Am Hawerkamp 31 48155 Münster www.mv-verlag.de
Layout Cover:	www.cey-x.de
Bezugsmöglichkeiten:	Universitätsbibliothek der TU Ilmenau Tel.: +49 3677 69-4615 Fax: +49 3677 69-4602

Preface

Dear Participants,

Confronted with the ever-increasing complexity of technical processes and the growing demands on their efficiency, security and flexibility, the scientific world needs to establish new methods of engineering design and new methods of systems operation. The factors likely to affect the design of the smart systems of the future will doubtless include the following:

- As computational costs decrease, it will be possible to apply more complex algorithms, even in real time. These algorithms will take into account system nonlinearities or provide online optimisation of the system's performance.
- New fields of application will be addressed. Interest is now being expressed, beyond that in "classical" technical systems and processes, in environmental systems or medical and bioengineering applications.
- The boundaries between software and hardware design are being eroded. New design methods will include co-design of software and hardware and even of sensor and actuator components.
- Automation will not only replace human operators but will assist, support and supervise humans so that their work is safe and even more effective.
- Networked systems or swarms will be crucial, requiring improvement of the communication within them and study of how their behaviour can be made globally consistent.
- The issues of security and safety, not only during the operation of systems but also in the course of their design, will continue to increase in importance.

The title "Computer Science meets Automation", borne by the 52nd International Scientific Colloquium (IWK) at the Technische Universität Ilmenau, Germany, expresses the desire of scientists and engineers to rise to these challenges, cooperating closely on innovative methods in the two disciplines of computer science and automation.

The IWK has a long tradition going back as far as 1953. In the years before 1989, a major function of the colloquium was to bring together scientists from both sides of the Iron Curtain. Naturally, bonds were also deepened between the countries from the East. Today, the objective of the colloquium is still to bring researchers together. They come from the eastern and western member states of the European Union, and, indeed, from all over the world. All who wish to share their ideas on the points where "Computer Science meets Automation" are addressed by this colloquium at the Technische Universität Ilmenau.

All the University's Faculties have joined forces to ensure that nothing is left out. Control engineering, information science, cybernetics, communication technology and systems engineering – for all of these and their applications (ranging from biological systems to heavy engineering), the issues are being covered.

Together with all the organizers I should like to thank you for your contributions to the conference, ensuring, as they do, a most interesting colloquium programme of an interdisciplinary nature.
I am looking forward to an inspiring colloquium. It promises to be a fine platform for you to present your research, to address new concepts and to meet colleagues in Ilmenau.

Professor Peter Scharff
Rector, TU Ilmenau

Professor Christoph Ament
Head of Organisation

Table of Contents

C O N T E N T S

Page

10 Mobile Communications

11 Education in Computer Science and Automation

A. Diab, H-D. Wuttke, K. Henke, A. Mitschele-Thiel, M. Ruhwedel

MAeLE: A Metadata Driven Adaptive eLearning Environment

ABSTRACT

The topic eLearning is taking on an increasingly important role in the discussion about modern teaching and learning methods. New technologies and in particular the Internet open many new opportunities, however in many cases these have not yet been exhausted. For example the management of large amounts of information and the provision of eLearning show that many demands remain to be met. Designing and Implementing of adaptive eLearning environments is a major point of interest. Currently, many learning environments offer little or no support for adaptivity. This is especially regrettable for personalize the content. In this paper we present a new SCORM compatible Metadata Driven Adaptive eLearning Environment (MAeLE). MAeLE is a framework for personalized adaptive eLearning. The adaptivity depends on the user characteristics and on adaptation metadata, which describe the contents and define how the adaptivity events should take place. The contents themselves do not contain any sequence logic or metadata. MAeLE generates a personalized course with adequate navigation and strategy at run time. A main advantage of MAeLE is its flexibility, extensibility and compatibility to SCORM standard.

I- INTRODUCTION

E-learning was identified as one of the very important areas in the last few years. New technologies and in particular the Internet open many new opportunities, however in many cases these have not yet been exhausted. Using the new technologies can improve the knowledge transfer itself. However, in order to be able to cover the problematic areas that can not be covered by these technologies [1] or the problematic areas of the learner himself like weaknesses and even disabilities of learners, eLearning contents should be personalized and adapted to the learner.

There are two main directions for improving the adaptivity in eLearning [2]. The first one is the learner-centric approach, while the other approach aims to improve the authoring facilities. The first approach describes how the learning contents can be adapted according to the learner's requirements. These requirements can be for example the goals of the user, previous knowledge or a preferred learning style. The data concerning to the preferences of the user and the events resulting from the user’s behaviour are stored in the user model. These data can be gathered by explicit user inputs, observing their behavior and by tracking the user’s progress [2].

The second approach can be made by providing a more comfortable environment for creating, linking and reusing learning materials. The platforms, currently used in universities, provide a good support for student administration, progress tracking and editing tools for authors. However, the support for individualization and adaptivity is still to be developed [2].

The paper is organized as follows: In section (II) the well known adaptive eLearning environments are discussed. MAeLE will be presented in details in section (III). After that, we conclude with the main results and the future work in section (IV).

II- RELATED WORK

The Sharable Content Object Reference Model (SCORM) [3], is a well known model for eLearning environments. It has get a great acceptance in different fields of eLearning. However, the adaptation abilities of SCORM are very restricted and focused only on allowing the defining of several organizations for the same course and defining of sequencing information, which allows determining a set of rules to select the next activity to be shown. [4] tries to enhance SCORM with adaptivity. Adaptivity on two levels is proposed. The first is adaptivity at the activity level, while the second is adaptivity at the Sharable Content Object (SCO) level. Adaptivity at the activity level depends mainly on a set of sub-activities related to each other according to pre-defined adaptation rules. Adaptivity at the SCO level depends on self-adaptive SCOs. It is mentioned that the SCOs should be able to show different behaviors according to the user’s characteristics. Trnkova et. al. [2] present and implement an e-learning environment called Adaptive Learning Environment (ALE). It integrates an intelligent tutoring system, a computer instruction management system and a set of cooperative tools. This generic environment can produce individualized courseware for students, based on their current state of knowledge, their preferences and learning styles according to the chosen learning strategy. The authors can create contents using pre-defined templates. These templates combine several content elements with different pedagogical functions, e.g. introduction, definition...etc. Metadata are added to each content element too. The user model records the "*interaction history*", "*tested knowledge*", and the "*user's readiness*", which results from comparing the learner object pre-requests with the "*interaction history*" of the user.

Leidig [5] presents a learning environment called L^3 (life-long learning). L^3 is a learning platform combining the functionality of a traditional Learning Management System (LMS) with the power of a Content Management System (CMS). L^3 defines four types of containers of the course materials, namely *learning networks*, *learning objects*, *instructional elements* and *tests*. Instructional elements represent the actual learning contents. Many instructional elements are combined in a learning object. Learning paths are defined in each course depending on the relations between the elements and their content type. L^3 defines two categories of strategies, macro and micro strategy. Macro strategies are responsible for defining the order of the higher-level elements, while micro strategies cover the order of the instructional elements.

Conlan [6] proposes a multi-model metadata driven approach for adaptivity. This approach enhances the eLearning contents with metadata to support adaptivity. This approach separates the content and the sequencing logic into two models namely content and narrative model. The content model contains metadata description of a piece of learning content with a reference to this learning content, while the narrative model stands for the adaptive logic. The adaptivity engine uses these metadata and produces depending on the user model a personalized course at run-time.

III- MAeLE: A METADATA DRIVEN ADAPTIVE ELEARNING ENVIRONMENT

a) Objectives and requirements of MAeLE

Similar to [6], in order to overcome the shortcomings of the other adaptive eLearning environments, the developed environment should deliver adequate eLearning experience to the learner. Of course, the pedagogical aspects should be taken into account. The developed environment should provide different adaptive effects based on different sets of models. Additionally, it should be extensible and accept new adaptive models and rules. The contents, built in this environment, should be reusable in other eLearning systems. Presentation and navigation adaptivity should be kept separate. This helps to ensure the reusability. Adaptivity metadata should be added to the contents, navigation methods and strategies. New navigation methods and strategies should be added simply to the environment. A main requirement of the system is that it should react dynamically to any changes in the user's behavior and change the whole or a part of the course. The behavior of the adaptive eLearning environment should be easy configurable through adequate parameters. An important requirement is that the developed eLearning environment should be compatible with SCORM model.

b) Structure of MAeLE

MAeLE extends the functionality of a traditional LMS through developing an adaptivity framework. The main structure of MAeLE is plotted in figure 1.

The user model is used to characterize the user, mainly depending on the current state of knowledge, preferences, learning styles, goal of the course…etc. Some user parameters are entered by the user himself. Some others are obtained through tracking the user's behavior during the use of the system. Keeping the user model in a separate block simplifies the extending of it and even enables the use of a new user model.

It highly recommended that the content should be reusable. Therefore, the eLearning contents should not contain any sequence logic or metadata. The eLearning contents are saved in small meaningful learning objects, *referred to assets in SCORM model*. The metadata for each asset are written in a separate database, called *"**Metadata**" in figure 1*. These metadata describe the content and contains adaptive data, which will be used to build / alter the adaptive course. A reference to the adequate strategy should exist in these metadata, if the asset is only suitable for one or more strategies.

Metadata about the supported eLearning strategies and navigation methods are recorded in separate databases, called *"**Dedactical Strategies**" and "**Navigation**" in figure 1*. These metadata contain a description of the strategies / navigation methods and a pointer to the actual implementation of strategies / navigation methods. This enables adding new strategies and / or new navigation methods simply to the system without the need to change the code of other parts of MAeLE.

The adaptation engine is the main component of MAeLE, its task is to determine the structure of the course, depending on the user's characters and on the metadata. In other words, it has to define the adequate eLearning contents as well as the adequate strategy and navigation method for a certain user. The adaptation is relayed on some adaptivity rules. In order to make MAeLE flexible and extensible with respect to new adaptivity rules, these rules are recorded in a separate database, called *“Rules” in figure 1*. In this way new adaptation rules can be added easily to the system. The adaptation engine should read only the adaptation metadata and the adaptation rules and generate thereafter the structure of the desired course.

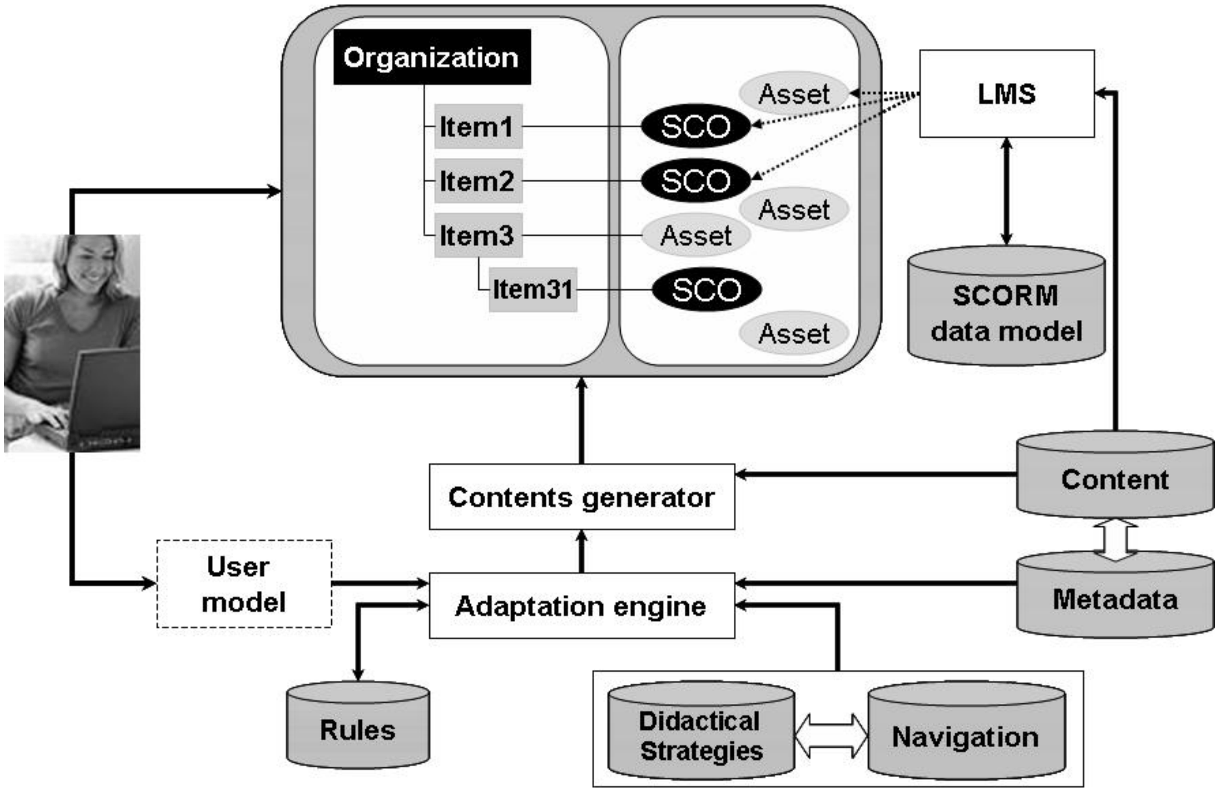

Figure 1: Structure of MAeLE

The output of the adaptation engine is a set of parameters, which defines accurately the desired contents, the adequate strategy and the suitable navigation method. These parameters are fed in the content generator, which in turn generates the required course and build the defined navigation.

At run time, the system records the behavior of the user, e.g., *which links has been visited*, *which kind of eLearning content is preferred*…etc. The user’s behavior can be tracked using other technologies, e.g., eye tracking [7]. This may change the user’s characters on run-time. MAeLE reacts dynamically on such changes and re-generates the whole or a part of the course. In addition to this, the system may propose changing or altering some rules, depending on the obtained experience. These changes should be performed however by an administrator to ensure that the system stays controllable.

IV- CONCLUSION AND FUTURE WORK

In this paper we have presented a new metadata driven adaptive eLearning environment (MAeLE). The proposed environment extends the functionality of a traditional LMS through an adaptivity framework. MAeLE generates personalized eLearning courses with an adequate navigation and strategy at run time. The adaptivity in MAeLE depends on the user's characteristics and on adequate metadata. The separation between contents and sequence logic or metadata enables the reusability of the contents, which is a main requirement of an eLearning environment. The proposed framework is flexible and extendable. New rules, strategies, navigation methods and contents can be simply added to the environment. The main advantage of MAeLE is its compatibility with SCORM. This enables it to be integrated in current LMSs.

References:

[1] T. Dietinger, " Aspects of E-Learning Environments", Dissertation at Graz University of Technology, Austria, 2003.
[2] J. Trnkova', G. Roeoßling, M. Muehlhaeuser, " L4 - A Sophisticated Adaptive E-Learning Laboratory ", Workshop Ontologie-basiertes Wissensmanagement (WOW), 2003.
[3] Advanced Distributed Learning, http://www.adlnet.gov/scorm/20043ED/Documentation.aspx, last visit: Juni, 2007
[4] M. Rey-López et al., " Providing SCORM with adaptivity", WWW 2006
[5] T. Leidig, " L3 - Towards an Open Learning Environment ", Journal of Educational Resources in Computing (JERIC), 2001.
[6] O. Conlan, " The Multi-Model, Metadata Driven Approach to Personalised eLearning Services ", PhD thesis, Trinity College, Dublin, 2004.
[7] V. Garcia Barrios, C. Gütl, A. Preis, K. Andrews, M. Pivec, C. fmoedrit, Trummer " AdELE: A Framework for Adaptive E-Learning through Eye Tracking" , Proceedings of IKNOW 2004, Graz, Austria.

Authors:

Dipl.-Ing Ali Diab
Dr.-Ing. Heinz- Dietrich Wuttke
Dr.-Ing. Karsten Henke
Prof. Dr.-Ing. habil. Andreas Mitschele-Thiel
Michael Ruhwedel
TU-Ilmenau, Faculty for Informatic and Automation, Gustav-Kirchhoff-Str. 1, P.O.B. 10 0565
98693, Ilmenau
Phone: +49 3677 69 2821
Fax: +49 3677 69 1220
E-mail: {ali.diab|dieter.wuttke| Karsten.Henke|mitsch}@tu-ilmenau.de / ruhwedel@freenet.de